DESCRIPTION OF PLATES.

PLATE 1.

T. brucei vel *rhodesiense*. Short and stumpy forms, 16–21 microns in length. Stained Giemsa. × 2000.

PLATE 2.

T. brucei vel *rhodesiense*. Intermediate forms, 22–24 microns in length. Stained Giemsa. × 2000.

PLATE 3.

T. brucei vel *rhodesiense*. Long and slender forms, 25–32 microns in length. Stained Giemsa. × 2000.

The Trypanosome causing Disease in Man in Nyasaland.—Susceptibility of Animals to the Human Strain.

By Surgeon-General Sir DAVID BRUCE, C.B., F.R.S., A.M.S.; Majors DAVID HARVEY and A. E. HAMERTON, D.S.O., R.A.M.C.; and Lady BRUCE, R.R.C.

(Scientific Commission of the Royal Society, Nyasaland, 1913.)

(Received May 26,—Read June 12, 1913.)

INTRODUCTION.

In previous papers the morphology of various strains of this trypanosome —from man, wild game and wild *Glossina morsitans*—was described, and the different strains compared.

This paper describes the action on animals of the five strains derived from cases of trypanosome disease in man in Nyasaland, and compares their virulence. In a future paper it is proposed to describe in the same way the action on animals of the Wild-game and Wild *G. morsitans* strains, but up to the present this has been impossible on account of the scarcity of experimental animals.

ANIMALS SUSCEPTIBLE TO THE TRYPANOSOME CAUSING DISEASE IN MAN IN NYASALAND. I.—THE HUMAN STRAIN.

I. *Strain I, Mkanyanga.*

Table I.

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Cattle.			
1912.					
Feb. 7...	167	From Rat 36	—	—	Never showed trypanosomes.
„ 7...	168	„ 36	13	134	Died of Strain I.
April 23...	473	From Guinea-pig 373...	—	—	Never showed trypanosomes.
„ 23...	474	„ 373...	9	—	Still alive after 325 days.
		Goats.			
Feb. 7...	142	From Rat 36	8	33	Died of Strain I.
„ 7...	144	„ 36	8	19	„ „
„ 7...	146	„ 36	—	—	Never showed trypanosomes.
„ 7...	149	„ 36	22	27	Died of Strain I.
April 23...	411	From Guinea-pig 373...	9	55	„ „
„ 23...	417	„ 373...	6	25	„ „
„ 23...	418	„ 373...	44	45	„ „
		Average.....	16·2	34·0	
		Sheep.			
Feb. 7...	162	From Rat 36	2	19	Died of Strain I.
„ 7...	163	„ 36	2	23	„ „
„ 7...	164	„ 36	2	33	„ „
April 23...	475	From Guinea-pig 373...	9	16	„ „
„ 23...	476	„ 373...	9	53	„ „
„ 23...	477	„ 373...	13	57	„ „
		Average.....	6·2	33·5	
		Baboon.			
1911.					
Dec. 21...	12	From Monkey 3.....	—	—	Never showed trypanosomes.
		Monkeys.			
Nov. 16...	3	Mkanyanga.....	14?	35	Died of Strain I.
1912.					
Jan. 19...	24	From Guinea-pig 13 ...	11?	28	„ „
Feb. 16...	233	From Monkey 24	3	28	„ „
„ 16...	234	„ 24	3	16	„ „
April 23...	469	From Guinea-pig 373...	13	31	„ „
„ 23...	470	„ 373...	6	42	„ „
		Average.....	6·2	30·0	

* Duration includes the days of incubation; it dates from day of infection.

Table I—*continued.*

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Dogs.			
1911.					
Oct. 15...	1	Mkanyanga	11 ?	46	Died of Strain I.
Nov. 16...	2	From Dog 1.....	14 ?	21	,, ,,
Dec. 7...	7	,, 2.....	8	20	,, ,,
,, 20...	11	,, 7.....	9	30	,, ,,
1912.					
Jan. 15...	14	,, 11.....	8	14	,, ,,
,, 31...	111	,, 14.....	6	14	,, ,,
		Average.....	7·7	24·2	
		Rabbit.			
June 14...	671	From Sheep 476.....	12	42	Died of Strain I.
		Guinea-pigs.			
1911.					
Dec. 16...	5	From Rat 4.....	13 ?	13	Died of Strain I.
,, 21...	13	From Monkey 3	11	100	,, ,,
1912.					
Feb. 7...	165	From Rat 36	12	42	,, ,,
,, 7...	166	,, 36	15	36	,, ,,
Mar. 27...	372	From Guinea-pig 13 ...	19	72	,, ,,
,, 27...	373	,, 13 ...	15	—	Killed April 23.
		Average.....	15·2	52·5	
		Rats.			
1911.					
Nov. 28...	4	From Dog 1.....	8	19	Died of Strain I.
Dec. 16...	8	From Rat 4.....	—	—	Never showed trypanosomes.
,, 16...	9	,, 4.....	?	13	Died of Strain I.
,, 29...	36	,, 9.....	25 ?	—	Killed.
,, 29...	37	,, 9.....	24 ?	26	Died of Strain I.
,, 29...	38	From Monkey 3.....	25 ?	33	,, ,,
1912.					
Feb. 16...	235	,, 24.....	4	25	,, ,,
,, 16...	236	,, 24.....	4	14	,, ,,
April 23...	471	From Guinea-pig 373...	7	15	,, ,,
,, 23...	472	,, 373...	6	22	,, ,,
Nov. 8...	1575	From Ox 474	—	—	Never showed trypanosomes.
		Average.....	6·0	20·9	

* Duration includes the days of incubation ; it dates from day of infection.

II. *Strain II, E——.*

Table II.

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Cattle.			
1912.					
June 28...	764	From Dog 633.....	—	—	Never showed trypanosomes.
,, 28...	765	,, 633.....	—	—	,, ,,
,, 28...	766	,, 633.....	27 ?	—	Shot November 20; broke leg.
		Goats.			
June 19...	643	From Dog 633.....	12	52	Died of Strain II.
,, 19...	650	,, 633.....	12	49	,, ,,
,, 19...	651	,, 633.....	5	62	,, ,,
,, 19...	652	,, 633.....	12	43	,, ,,
		Average.....	10·2	51·5	
		Sheep.			
June 28...	761	From Dog 633.....	10	87	Died of Strain II.
		Monkeys.			
June 26...	750	From Dog 633.....	5	17	Died of Strain II.
,, 26...	751	,, 633.....	5	27	,, ,,
,, 26...	752	,, 633.....	5	11	,, ,,
,, 26...	753	,, 633.....	8	10	,, ,,
		Average.....	5·7	16·2	
		Dogs.			
May 29...	632	From E——	12 ?	30	Died of Strain II.
,, 29...	633	From E——	12 ?	33	,, ,,
June 18...	703	From Dog 633.....	6	24	,, ,,
,, 18...	704	,, 633.....	6	40	,, ,,
		Average.....	6·0	31·8	
		Rabbits.			
June 28...	762	From Dog 633.....	13	33	Died of Strain II.
,, 28...	763	,, 633.....	17	33	,, ,,
		Average.....	15·0	33·0	
		Guinea-pigs.			
June 19...	723	From Dog 633.....	—	—	Never showed trypanosomes.
,, 19...	724	,, 633.....	—	—	,, ,,
,, 19...	725	,, 633.....	—	—	,, ,,
Sept. 7...	723	From Sheep 761.....	12	114	Died of Strain II.
,, 7...	724	,, 761.....	19	86	,, ,,
,, 7...	725	,, 761.....	19	84	,, ,,
		Average.....	17·0	94·7	
		Rats.			
June 19...	726	From Dog 633.....	5	43	Died of Strain II.
,, 19...	727	,, 633.....	8	36	,, ,,
,, 19...	728	,, 633.....	5	52	,, ,,
		Average.....	6·0	43·7	

* Duration includes the days of incubation; it dates from day of infection.

III. *Strain III, Chituluka.*

Table III.

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Cattle.			
1912.					
July 23...	967	From Dog 577.....	20	—	Still alive after 234 days.
„ 23...	968	„ 577.....	83	—	„ „
		Goats.			
July 23...	937	From Dog 577.....	13	36	Died of Strain III.
„ 23...	938	„ 577.....	9	19	„ „
„ 23...	939	„ 577.....	9	41	„ „
„ 23...	940	„ 577.....	6	29	„ „
		Average.....	9·2	31·2	
		Monkeys.			
July 23...	941	From Dog 577.....	6	29	Died of Strain III.
„ 23...	942	„ 577.....	6	14	„ „
„ 23...	943	„ 577.....	6	20	„ „
„ 23...	944	„ 577.....	6	11	„ „
		Average.....	6·0	18·5	
		Dogs.			
June 27...	577	Chituluka	7	78	Died of Strain III.
July 23...	945	From Dog 577.....	9	31	„ „
„ 23...	946	„ 577.....	6	36	„ „
„ 23...	947	„ 577.....	9	33	„ „
„ 23...	948	„ 577.....	9	33	„ „
		Average.....	8·0	42·2	
		Guinea-pigs.			
July 23...	949	From Dog 577.....	20	62	Died of Strain III.
„ 23...	950	„ 577.....	20	51	„ „
„ 23...	951	„ 577.....	9	73	
		Average.....	16·3	62	
		Rats.			
July 23...	952	From Dog 577.....	6	24	Died of Strain III.
„ 23...	953	„ 577.....	9	20	„ „
„ 23...	954	„ 577.....	6	21	„ „
		Average.....	7·0	21·7	

* Duration includes the days of incubation; it dates from day of infection.

IV. *Strain IV, Chipochola.*

Table IV.

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Cattle.			
1912.					
Sept. 13...	1319	From Dog 1260	—	—	Never showed trypanosomes.
„ 13...	1320	„ 1260	—	—	„ „
Nov. 8...	1319	From Rat 1338	20	—	Still alive after 126 days.
„ 8...	1320	„ 1338	—	—	Never showed trypanosomes.
		Goats.			
Sept. 13...	1321	From Dog 1260	10	35	Died of Strain IV.
„ 13...	1322	„ 1260	13	59	„ „
„ 13...	1323	„ 1260	6	22	„ „
„ 13...	1324	„ 1260	24	33	„ „
		Average.....	13·2	37·2	
		Monkeys.			
Sept. 13...	1325	From Dog 1260	10	16	Died of Strain IV.
„ 13...	1326	„ 1260	10	50	„ „
„ 13...	1327	„ 1260	6	51	„ „
„ 13...	1328	„ 1260	—	—	Never showed trypanosomes.
		Average.....	8·7	39·0	
		Dogs.			
Sept. 4...	1260	Chipochola	8	32	Died of Strain IV.
„ 13...	1329	From Dog 1260	6	27	„ „
„ 13...	1330	„ 1260	6	27	„ „
„ 13...	1331	„ 1260	6	38	„ „
„ 13...	1332	„ 1260	6	40	„ „
		Average.....	6·4	32·8	
		Rabbits.			
Nov. 6...	1566	From Rat 1338	5	15	Died of Strain IV.
„ 6...	1567	„ 1338	5	16	„ „
		Average.....	5	15·5	
		Guinea-pigs.			
Sept. 13...	1333	From Dog 1260	—	—	Never showed trypanosomes.
„ 13...	1334	„ 1260	—	—	„ „
„ 13...	1335	„ 1260	—	—	„ „
Oct. 17...	1333	„ 1331	11	43	Died of Strain IV.
„ 17...	1334	„ 1331	11	70	„ „
„ 17...	1335	„ 1331	11	59	„ „
		Average.....	11·0	57·3	
		Rats.			
Sept. 13...	1336	From Dog 1260	6	26	Died of Strain IV.
„ 13...	1337	„ 1260	6	28	„ „
„ 13...	1338	„ 1260	6	93	„ „
		Average.....	6·0	49·0	

* Duration includes the days of incubation; it dates from day of infection.

V. *Strain V, Chibibi.*

Table V.

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
		Goats.			
1912.					
Nov. 27...	1643	From Dog 1599	8	64	Died of Strain V.
,, 27...	1644	,, 1599	8	72	,, ,,
,, 27...	1645	,, 1599	5	41	,, ,,
,, 27...	1646	,, 1599	5	64	,, ,,
		Average.....	6·5	60·2	
		Monkeys.			
Nov. 27...	1647	From Dog 1599	8	11	Died of Strain V.
,, 27...	1648	,, 1599	—	—	Never showed trypanosomes.
,, 27...	1649	,, 1599	5	21	Died of Strain V.
,, 27...	1650	,, 1599	5	44	,, ,,
		Average.....	6·0	25·3	
		Dogs.			
Nov. 14...	1599	Chibibi.....	11	44	Died of Strain V.
,, 27...	1651	From Dog 1599	8	46	,, ,,
,, 27...	1652	,, 1599	5	34	,, ,,
,, 27...	1653	,, 1599	8	45	,, ,,
,, 27...	1654	,, 1599	5	41	,, ,,
1913.					
Jan. 15...	1768	From Rat 1744	12	—	Killed January 31.
		Average.....	8·2	42·0	
		Rabbits.			
1912.					
Nov. 27...	1655	From Dog 1599	8	33	Died of Strain V.
,, 27...	1656	,, 1599	8	23	,, ,,
		Average.....	8·0	28·0	
		Guinea-pigs.			
Nov. 27...	1657	From Dog 1599	—	—	Never showed trypanosomes.
,, 27...	1658	,, 1599	36	102	Died of Strain V.
,, 27...	1659	,, 1599	—	—	Never showed trypanosomes.
1913.					
Jan. 31...	1657	,, 1768	—	—	,, ,,
Feb. 10...	1657	From Guinea-pig 1658	10	—	Still alive after 43 days.
,, 10...	1659	,, 1658	24	—	,, ,,
		Average.....	23·3	—	

* Duration includes the days of incubation; it dates from day of infection.

Table V—*continued.*

Date.	No. of expt.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
			Rats.		
1912.					
Nov. 27...	1660	From Dog 1599	5	38	Died of Strain V.
„ 27...	1661	„ 1599	5	30	„ „
„ 27...	1662	„ 1599	8	39	„ „
1913.					
Jan. 8...	1744	From Guinea-pig 1658	6	—	Killed January 22.
„ 28...	1817	From Monkey 1733 ...	2	20	From Transmission Experiment 1723. Died of Strain V.
		Average.....	5·2	31·8	

* Duration includes the days of incubation; it dates from day of infection.

Disease set up in Various Animals by the Trypanosome causing Disease in Man in Nyasaland.—I. *The Human Strain.*

Ox.—This trypanosome is not as deadly to oxen as *Trypanosoma pecorum*; 13 experiments in all were made on cattle with the Human strain. Only one of these died, after an illness lasting 134 days. Four took the disease and recovered, while the remaining eight showed themselves refractory to the injection of blood containing the parasites. One of the recovered animals has been kept under observation for 325 days, and its blood was inoculated into a rat without result. At the present time these so-called recovered animals appear sleek and fat and look healthy, presenting a contrast to the chronic *T. pecorum* infected cattle, which still remain in poor condition. The animal which died was much emaciated, anæmic, and had marked gelatinous infiltration of the connective tissue at the base of the heart and large vessels. The trypanosomes were never numerous in its blood, and in fact only showed six times in the four and a-half months of its illness at the bi-weekly blood examination.

Goat.—This is a fatal disease in goats; 22 were used for experimental purposes, and not one of them recovered. The duration of the disease, on an average, was 41·8 days (19 to 72). One of these animals showed swelling of the face, but none developed opacity of the cornea.

Sheep.—This trypanosome seems as fatal to sheep as goats, killing seven, on an average, in 41·1 days (16 to 87). Among these seven, œdema of the face was noted as a prominent symptom in three. No opacity of cornea developed in any of them.

Baboon.—Only one was inoculated and it proved resistant.

Monkey.—Twenty monkeys died, on an average, in 25·8 days (10 to 51). The trypanosomes were always present in the blood and were often numerous or very numerous. In none of the monkeys was œdema of the face or corneal opacity noted.

Dog.—Twenty-five dogs were inoculated. All died, on an average, in 34·3 days (14 to 78). The parasites were always present on microscopical examination of the blood, and were often numerous and very numerous. In eight of the 25 dogs, opacity of the cornea and swelling of the face were present.

Rabbit.—Seven rabbits died, on an average, in 27·9 days (15 to 42). A rabbit suffering from this disease presents exactly the same clinical picture as that seen in rabbits suffering from Nagana. There is first swelling round the eyes; then the face puffs up, and sores break out round the nose and the eyes. Next there is thickening of the ears, which eventually also become covered with sores exuding a serous fluid. Towards the end the eyes are completely closed up, the nose much swollen, and both eyes and nose discharge a purulent fluid.

Guinea-pig.—These animals are more refractory than rabbits, and often require to be re-inoculated before they take the disease; 15 were used. They died, on an average, in 66·6 days (13 to 114). No prominent symptom, such as œdema or corneal opacity, was seen.

Rat.—Twenty-one were inoculated and died, on an average, in 30·3 days (13 to 93), with their blood swarming with trypanosomes and their spleens enormously enlarged.

Comparison of the Five Human Strains of the Trypanosome causing Disease in Man in Nyasaland, in regard to their Virulence towards Various Animals.

Table VI.—The Average Duration, in Days, of the Disease in Various Animals. The letter R means that the animal is refractory, that is, not susceptible to the disease.

Strain.	Ox.	Goat and sheep.	Baboon.	Monkey.	Dog.	Rabbit.	Guinea-pig.	White rat.
I.....	134	34	R	30	24	42	52	21
II.....		59		16	32	33	95	44
III.....		31		18	42		62	22
IV.....		37		39	33	15	57	49
V.....		60		25	42	28	102	32

There would appear to be little difference in the virulence of the five Human strains. If any distinction be made, it might be said that probably Strain I is the most and Strain V the least virulent.

Table VII.—The Percentages of Recoveries in Various Animals from the Five Human Strains. The letter R stands for refractory.

Strain.	Man.	Ox.	Goat and sheep.	Baboon.	Monkey.	Dog.	Rabbit.	Guinea-pig.	White rat.
I.....	0	50	0	R	0	0	0	0	0
II.....	0	?	0		0	0	0	0	0
III.....	0	100	0		0	0		0	0
IV.....	0	100	0		0	0	0	0	0
V.....	0		0		0	0	0	0	0

It would appear to be equally impossible to separate the Human strains by the percentages of recoveries. All the experimental animals, except the ox, succumb to the disease if once the parasite has obtained a footing.

Table VIII.—The Average Duration of Life, in Days, of Various Animals infected with the Human Strain. The letter R stands for refractory.

	Ox.	Goat and sheep.	Baboon.	Monkey.	Dog.	Rabbit.	Guinea-pig.	White rat.
Average duration, in days	134	42	R	26	34	28	67	30
No. of animals employed	1	29	1	20	25	7	15	21

This table shows the extreme virulence of this trypanosome for most animals except the ox. The guinea-pig is somewhat refractory, and often resists the first injection of infected blood, but not the second.

Table IX.—The Percentages of Recoveries in Various Animals infected with the Five Human Strains. The letter R stands for refractory.

	Man.	Ox.	Goat and sheep.	Baboon.	Monkey.	Dog.	Rabbit.	Guinea-pig.	White rat.
Percentages ...	0	80	0	R	0	0	0	0	0
No. of animals employed	5	5	29	1	20	25	7	15	21

CONCLUSIONS.

1. The trypanosome causing disease in man in Nyasaland is fatal to goats, sheep, dogs, and the smaller laboratory animals, killing them, without exception, in a few weeks. It is less virulent to cattle, many of which evidently escape.

2. No difference in virulence can be made out in these five Human strains.

3. It is not satisfactorily proved yet to what species this trypanosome belongs, but the Commission at present leans to the opinion that it is *T. brucei* (Plimmer and Bradford).

Plasmodium cephalophi, *sp. nov.*

By Surgeon-General Sir DAVID BRUCE, C.B., F.R.S., A.M.S.; Majors DAVID HARVEY and A. E. HAMERTON, D.S.O., R.A.M.C.; and Lady Bruce, R.R.C.

(Scientific Commission of the Royal Society, Nyasaland, 1913.)

(Received May 26,—Read June 12, 1913.)

[PLATES 4 AND 5.]

It would appear from a perusal of the available literature that malaria of antelopes has not hitherto been described; it is therefore proposed to place on record the discovery of a plasmodium found in the blood of two of these animals in Nyasaland.

This parasite was first seen in the blood of a young duiker (*Cephalophus grimmi*), and was subsequently discovered in another young animal of the same species. Both these small antelope were at the time in captivity, and it was therefore possible to examine slides from day to day, and by this means a large number of parasites at various stages of development were observed, and some of these are figured in Plates 4 and 5.

The acute attack in one antelope, however, only lasted four days, and the parasites soon disappeared entirely from the peripheral blood, whereas in the other only a few parasites were seen, and these have persisted in the blood for some months.

The parasites resemble somewhat *Plasmodium malariæ* of man, in that the gametocytes are circular and the schizonts have from eight to twelve merozoites; also amœboid movement is sluggish. They differ, however, in the marked enlargement and paleness of the red cell and in the arrangement